What is claimed are:

1. A wavelength division multiplexing optical transmission system, in which each signal light with different wavelengths output from a plurality of optical senders is multiplexed by an optical multiplexer to be transmitted to an optical transmission path, and wavelength division multiplexing signal light propagated through the optical transmission path is demultiplexed depending on respective wavelengths by an optical demultiplexer to be received by a plurality of optical receivers,

wherein each of said plurality of optical senders generates signal light in which a bit rate and frequency spacing thereof are set so as to approach spectrum efficiency at which the product of a transmission distance and a transmission capacity becomes a maximum value, said product being calculated based on the determination of the type of modulation of signal light and also the assumption of an equation model expressing transmission characteristics of said optical multiplexer and said optical demultiplexer, and

said optical multiplexer and said optical demultiplexer have transmission characteristics in which transmission bandwidth is set in accordance with said equation model, and also according to the spectrum efficiency at which the product of the transmission distance and the transmission capacity becomes a maximum value.

2. A wavelength division multiplexing optical transmission system according to claim 1,

wherein the type of modulation of said signal light is an NRZ modulation type, and

the equation model expressing the transmission characteristics of said optical multiplexer and said optical demultiplexer is the one in which the shape of each transmission band corresponding to the wavelength of each signal light is expressed, using a frequency f, the center frequency fc of the transmission band, full width at half maximum Δf of the transmission band, and a filter order "n", in the following equation,

$$T(f) = 10 \cdot \log\left[\exp\left\{-2 \cdot \ln\sqrt{2} \cdot \left(\frac{|f - fc|}{\Delta f/2}\right)^{2n}\right\}\right] \quad \text{(dB)}.$$

3. A wavelength division multiplexing optical transmission system according to claim 2,

wherein said filter order "n" is secondary, and the spectrum efficiency at which the product of said transmission distance and said transmission capacity becomes the maximum value is 0.574bit/s/Hz.

4. A wavelength division multiplexing optical transmission system according to claim 3,

wherein, when the bit rate B and frequency grid I per one wave of the signal light are given in advance, a natural number "k" is selected so as to minimize a difference between the spectrum efficiency B/(kI) where "k" is the natural number, and the spectrum efficiency at which the product of said transmission distance and said transmission capacity becomes the maximum value, so that frequency spacing S=kI, of the signal light is set in accordance with the natural number "k".

5. A wavelength division multiplexing optical transmission system according to claim 4,

wherein, when a value B/I obtained by dividing said bit rate B by said frequency grid I is 1.6 to 2.0bit/s/Hz, 3 is selected as said natural number "k".

6. A wavelength division multiplexing optical transmission system according to claim 5,

wherein, when 40 to 50Gbit/s is given as said bit rate B, and 25GHz interval is given as said frequency grid I, frequency spacing is set to 75GHz.

7. A wavelength division multiplexing optical transmission system according to claim 4,

wherein, when a value B/I obtained by dividing said bit rate B by said frequency grid I is 1.6bit/s/Hz, and 3 is selected as said natural number "k",

said optical multiplexer and said optical demultiplexer have transmission characteristics following said equation model in which said filter order "n" is 1.2 or more.

8. A wavelength division multiplexing optical transmission system according to claim 7,

wherein said optical multiplexer and said optical demultiplexer have transmission characteristics in which a valu Δf/fb obtained by dividing full width at

half maximum Δf of said transmission band by a clock frequency fb of the signal light, is within a range of 1.50 to 1.90.

9. A wavelength division multiplexing optical transmission system according to claim 4,

wherein, when a value B/I obtained by dividing said bit rate B by said frequency grid I is 1.7bit/s/Hz, and 3 is selected as said natural number "k",

said optical multiplexer and said optical demultiplexer have transmission characteristics following said equation model in which said filter order "n" is 1.5 or more,

10. A wavelength division multiplexing optical transmission system according to claim 9,

wherein said optical multiplexer and said optical demultiplexer have transmission characteristics in which a value Δf/fb obtained by dividing full width at half maximum Δf of said transmission band by a clock frequency fb of the signal light, is within a range of 1.45 to 1.95.

11. A wavelength division multiplexing optical transmission system according to claim 4,

wherein, when a value B/I obtained by dividing said bit rate B by said frequency grid I is 2.0bit/s/Hz, and 3 is selected as said natural number "k",

said optical multiplexer and said optical demultiplexer have transmission characteristics following said equation model in which said filter order "n" is 2 or mor .

12. A wavelength division multiplexing optical transmission system according to claim 11,

wherein said optical multiplexer and said optical demultiplexer have transmission characteristics in which a value Δf/fb obtained by dividing full width at half maximum Δf of said transmission band by a clock frequency fb of the signal light, is within a range of 1.35 to 1.70.

13. A wavelength division multiplexing optical transmission system according to claim 1,

wherein each of said optical multiplexer and said optical demultiplexer is constituted using an arrayed waveguide grating.

14. A wavelength division multiplexing optical transmission system according to claim 1,

wherein each of said optical multiplexer and said optical demultiplexer is constituted by combining an optical interleaver using an interference filter, and an arrayed waveguide grating.

15. A wavelength division multiplexing optical transmission system according to claim 1,

wherein each of said optical multiplexer and said optical demultiplexer is constituted by combining an optical interleaver using an interference filter, and a dielectric multi-layer film filter.

16. A wavelength division multiplexing optical transmission system according to claim 1,

wherein the spectrum efficiency at which the product of said transmission distance and said transmission capacity becomes the maximum value is calculated as spectrum efficiency at which a performance index $PI=10^{(-\Delta Q/10)} \cdot B/S$, which is expressed using a Q-value degradation amount ΔQ of the system, a bit rate B and frequency spacing S of the signal light, becomes a maximum value.

17. A wavelength division multiplexing optical transmission method of multiplexing a plurality of signal light with different wavelengths to transmit to an optical transmission path, and demultiplexing wavelength division multiplexed signal light propagated through said optical transmission path according to wavelength to receive,

wherein spectrum efficiency at which the product of a transmission distance and a transmission capacity becomes a maximum value is calculated based on the determination of the type of modulation of signal light and also the assumption of an equation model expressing transmission characteristics at the time of multiplexing and demultiplexing the signal light, and

a bit rate and frequency spacing of the signal light are set so as to approach the spectrum efficiency at which the product of said transmission distance and said transmission capacity becomes the maximum value, and also actual transmission characteristics at the time of multiplexing and demultiplexing the signal light is set in accordance with said equation model, to transmit the wavelength division multiplexed signal light.

18. A wavelength multiplexing apparatus for multiplexing optical signals with a plurality of wavelengths,

wherein each component on a short wavelength side and a long wavelength side of each of said optical signals is eliminated using a filter with a band narrower than spectrum width obtained based on a bit rate and a type of coding of each of said optical signals, to make spacing of said optical signals to be narrower than said spectrum width.

19. A wavelength multiplexing apparatus according to claim 18, comprising polarization independent optical parts.

20. A wavelength demultiplexing apparatus for demultiplexing wavelength division multiplexed light obtained by multiplexing optical signals with a plurality of wavelengths,

wherein each component on a short wavelength side and a long wavelength side of each of said optical signals is eliminated using a filter with a band narrower than spectrum width obtained based on a bit rate and a type of coding of each of said optical signals, to make spacing of said optical signals to be narrower than said spectrum width.

21. A wavelength demultiplexing apparatus according to claim 20, comprising polarization independent optical parts.

22. An optical transmission system including a wavelength multiplexing apparatus for multiplexing optical signals with a plurality of wavelengths to output to a transmission path, and a wavelength demultiplexing apparatus for demultiplexing wavelength division multiplexed light from said transmission path,

wherein each of said wavelength multiplexing apparatus and said wavelength demultiplexing apparatus eliminates each component on a short wavelength side and a long wavelength side of each of said optical signals using a filter with a band narrower than spectrum width obtained based on a bit rate and a type of coding of each of said optical signals, to make spacing of said optical signals to be narrower than said spectrum width.

23. An optical transmission system according to claim 22,

wh rein each of said wavelength multiplexing apparatus and said wavelength demultiplexing apparatus comprises polarization independent optical parts.

24. A wavelength division multiplexing optical transmission method, comprising the processes of:

generating a plurality of optical signals obtained by modulating a plurality of light with different wavelengths;

eliminating each component on a short wavelength side and a long wavelength side of spectrum of each of said optical signals to make each of said optical signal to have predetermined bandwidth; and

wavelength multiplexing said optical signal at the predetermined bandwidth to transmit wavelength division multiplexed signal light.